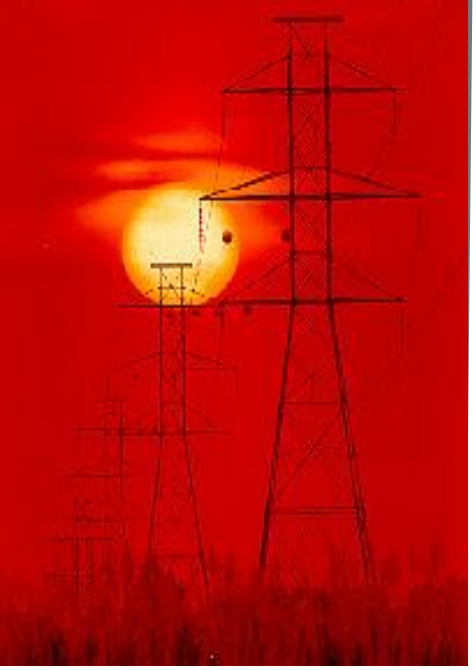


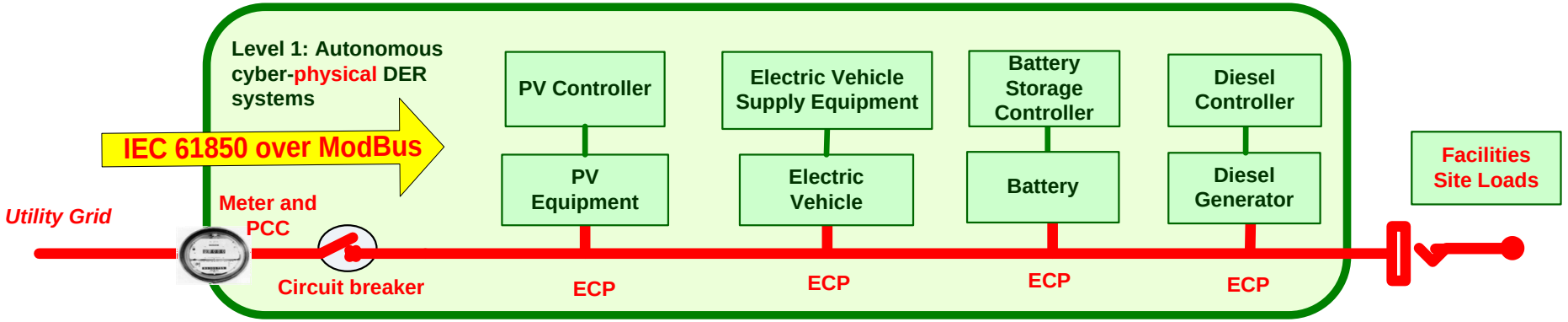
Candidate DER Functions

June 21, 2013 10:45 to 12:00

Xanthus
Consulting International

Phase 1: Autonomous DER Systems in a Customer or Utility Site

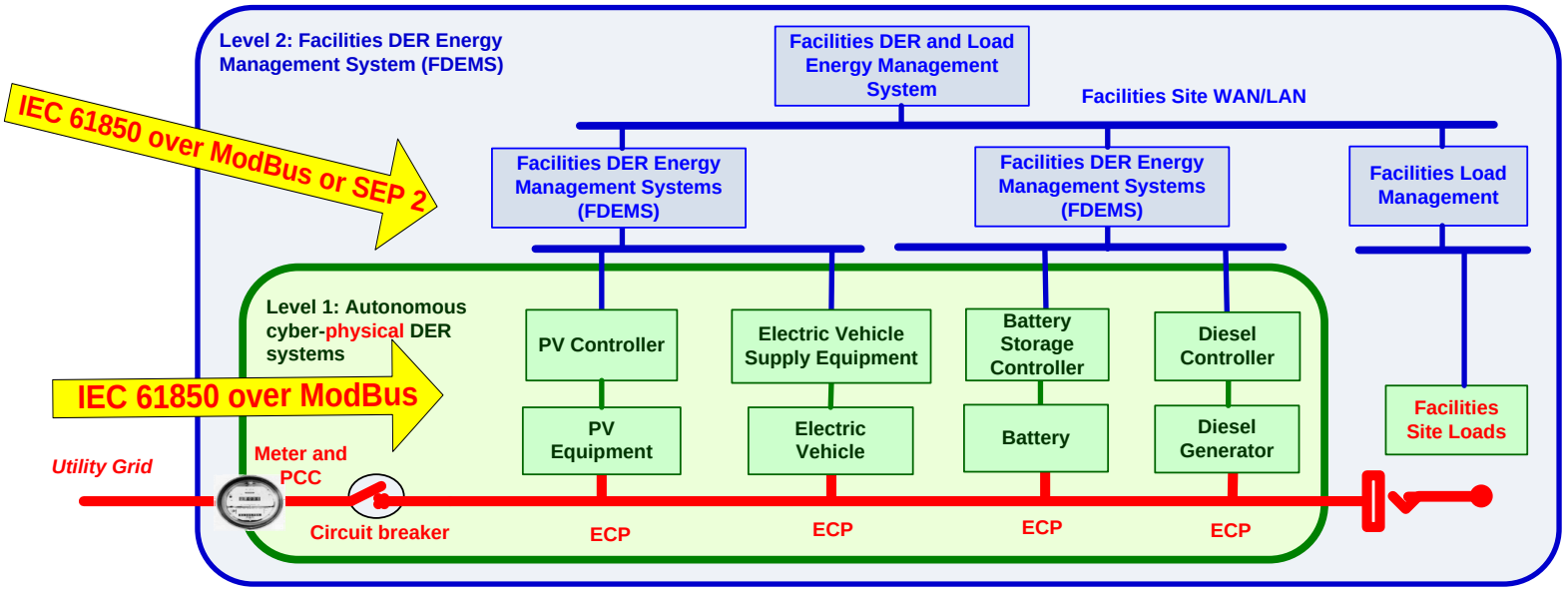
No external communications are involved, just internal communications between the controller and the physical device



- Data models are proprietary and specific to the type of device and the manufacturer
- ModBus is the protocol used by most inverter manufacturers for internal communications
- ModBus has no intrinsic cybersecurity, but may be embedded as payload in secure messages

Level 2: Facilities DER Energy Management System (FDEMS) to Manage Groups of DER Systems

FDEMS communicate with DER controllers to monitor, control, or request actions. May include multiple layers of DER Management systems.

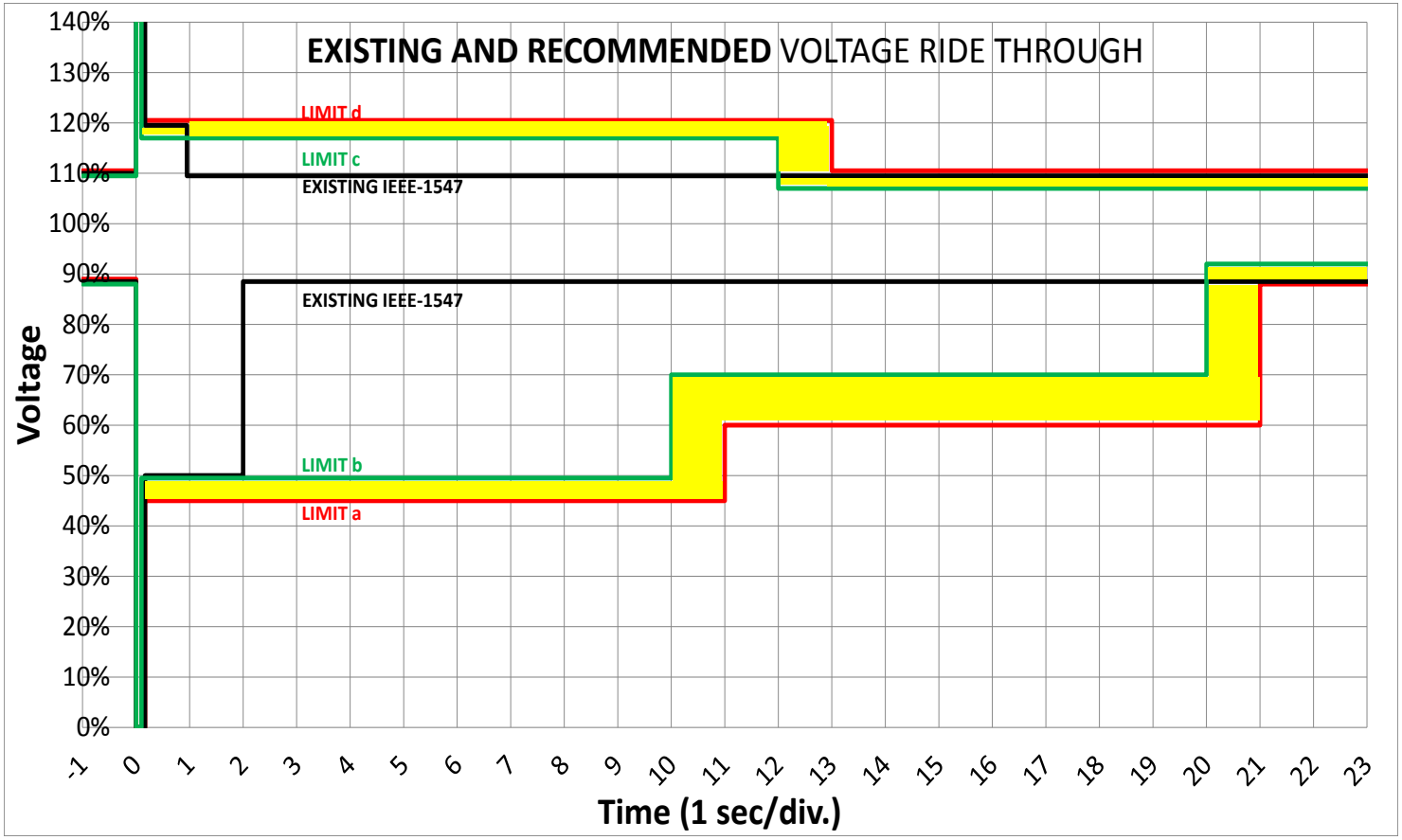


- IEC 61850-7-420/90-7 Information Models should be used between the DER controllers and the Facilities Energy Management Systems
- ModBus is predominantly used, while alternative protocols include SEP 2.0, OPC/UA, and BACnet.
- MMS (61850-8-1) may be used in Europe

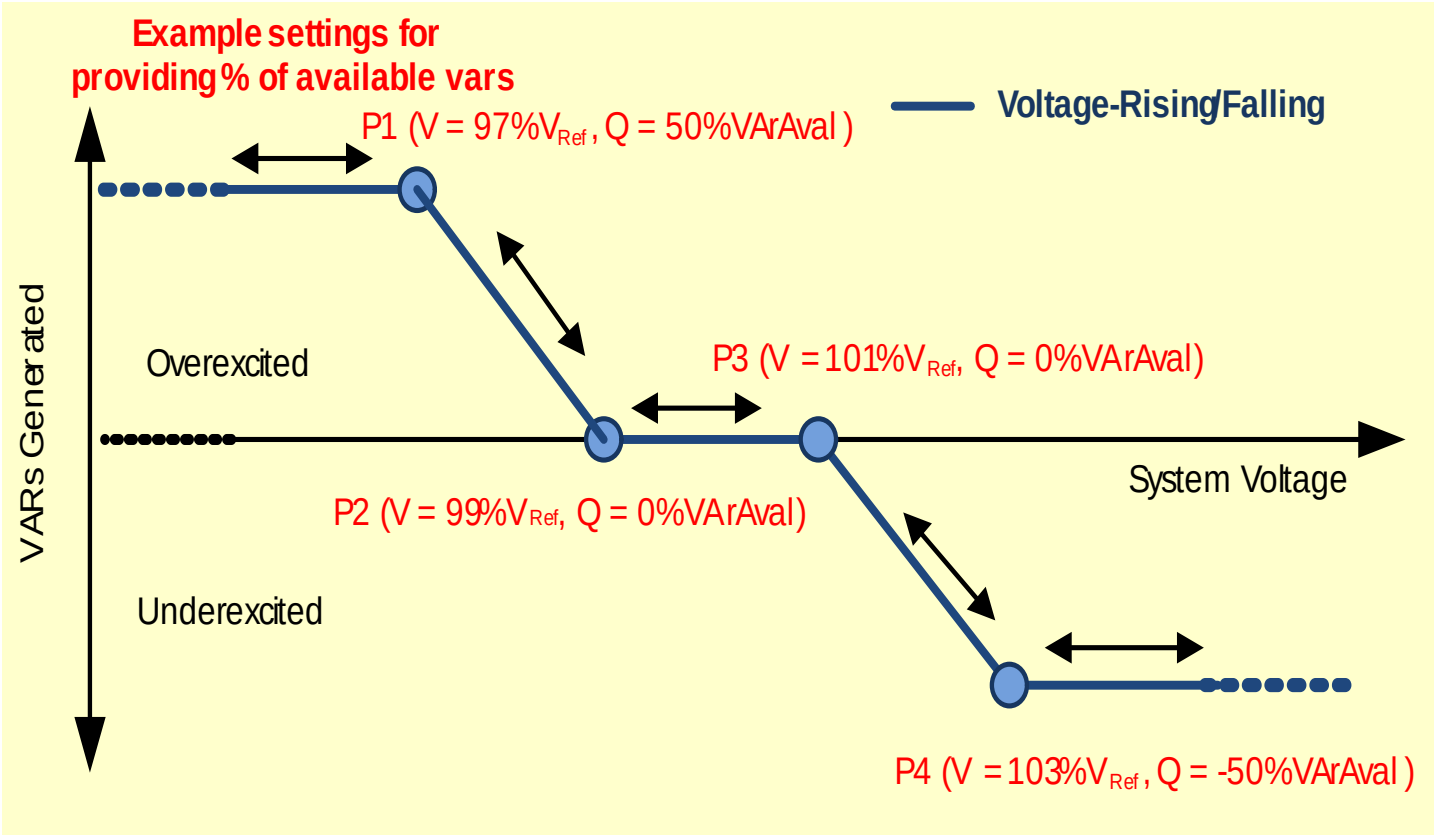
Candidate Phase 1 Mandatory Autonomous DER Functions

- Support **anti-islanding** to trip off under extended anomalous conditions
- Provide **ride-through of low/high voltage** excursions beyond normal limits (L/HVRT)
- Provide **ride-through of low/high frequency** excursions beyond normal limits (L/HFRT)
- Provide **volt/var control** by dynamic reactive power injection through autonomous responses to local voltage measurements (VV)
- **Counteract frequency excursions** beyond normal limits by decreasing or increasing real power (FW)
- **Counteract voltage excursions** beyond normal limits by providing dynamic current support
- **Reconnect randomly** within a preset time window after grid power is restored
- **Limit maximum real power output** at the PCC to a preset value
- **Modify real power output** autonomously in response to local voltage variations
- Provide reactive power by a **fixed power factor**
- **Set actual real power output** at the PCC
- **Schedule actual or maximum real power output** at specific times

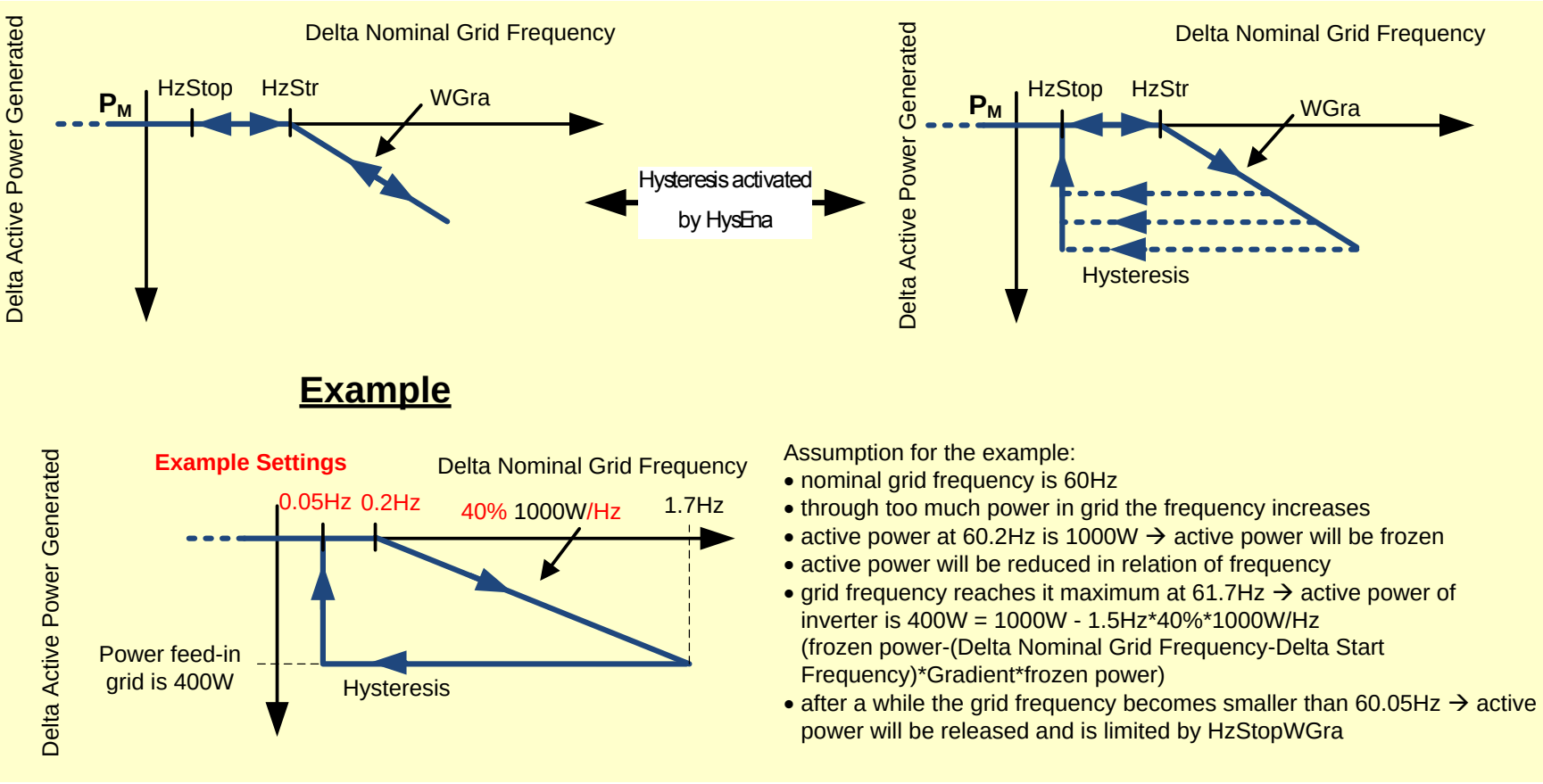
Voltage Ride-Through Settings



Volt-Var Control Function



Frequency-Watt Function

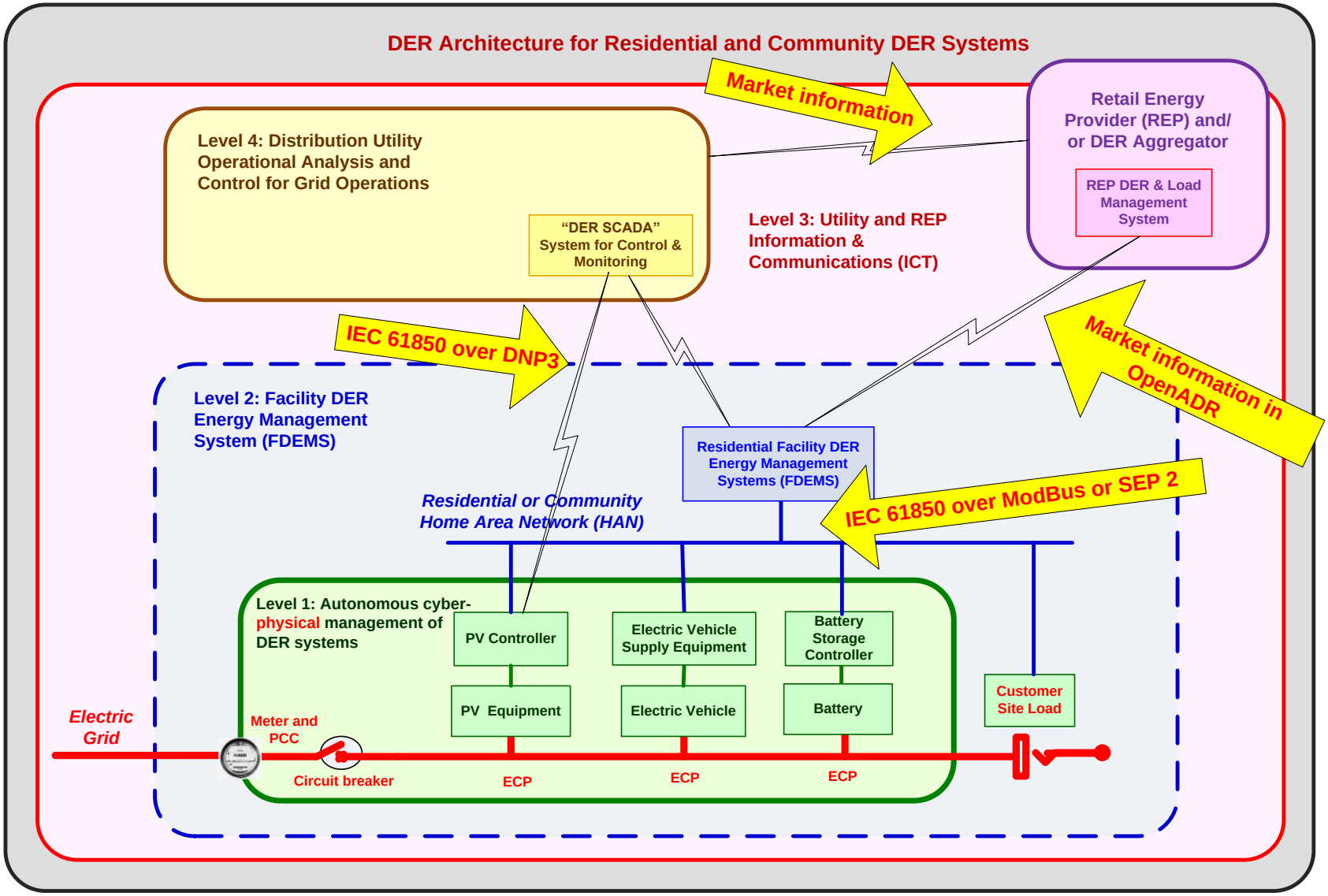


Example

Assumption for the example:

- nominal grid frequency is 60Hz
- through too much power in grid the frequency increases
- active power at 60.2Hz is 1000W → active power will be frozen
- active power will be reduced in relation of frequency
- grid frequency reaches it maximum at 61.7Hz → active power of inverter is 400W = 1000W - 1.5Hz*40%*1000W/Hz (frozen power-(Delta Nominal Grid Frequency-Delta Start Frequency)*Gradient*frozen power)
- after a while the grid frequency becomes smaller than 60.05Hz → active power will be released and is limited by HzStopWGra

Phase 2: DER Systems with Communications



Candidate Phase 2 Mandatory DER Functions with Communications

- Communication requirements:
  - Provide capability for **adding modules** for different media interfaces
  - Provide the **TCP/IP internet protocols**
  - Use the **IEC 61850 information model** for defining data exchanges
  - Support the **mapping of the IEC 61850** information model **to DNP3**
  - Provide **cyber security** with **user and device authentication**
- Communications used primarily for **updating autonomous settings**
- Communications for **situational awareness and control:**
  - Provide **emergency alarms** and information
  - Provide **status and measurements** on energy and ancillary services
  - **Limit maximum real power output** at the PCC upon a direct command from the utility

Phase 1 *Recommended* Autonomous DER Functions

- The following DER functions are recommended but not mandated:
  - **Smooth minor frequency deviations** by rapidly modifying real power output to these deviations
  - **Follow schedules** for energy and ancillary service outputs
  - **Set or schedule the storage** of energy for later delivery, indicating time to start charging, charging rate and/or “charge-by” time

Phase 2 *Recommended* DER Functions with Communications

- The following DER functions are recommended but not mandated:
  - Support **direct command to disconnect or reconnect**
  - Provide **operational characteristics** at initial interconnection and upon changes
  - **Test DER software** patching and updates